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Cover: Indian Grey Wolf *Canis lupus pallipes* and Smooth-coated Otter *Lutrogale perspicillata* sharing the territory in Chambal basin. Digital art on Procreate by Aakanksha Komanduri.

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ARTICLE

Nesting colonies and breeding ecology of the Cattle Egret *Bubulcus ibis* (Linnaeus, 1758) in northern and northeastern Bangladesh

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Abstract: A study on the Cattle Egret *Bubulcus ibis* was conducted between March 2017 and August 2023 in northern and northeastern Bangladesh to document the nesting sites and breeding biology of this species. A total of 218 colony sites were identified, of which 56.42% were active breeding ones, 17.43% night roosting, and 26.15% abandoned ones. The active breeding colony sites occupied 107.06 ha, with 1.10 ha of government land and 105.96 ha of private land. Active nesting sites ranged from 2–150 years old. The most active breeding colonies were found in Rajshahi (41) and Sylhet (41), followed by Rangpur (21) and Mymensingh (20). A total of 29,412 nests were counted, with Rajshahi at 38.29% (n = 11,262), Sylhet at 29.47% (n = 8,669), Rangpur at 19.49% (n = 5,731), and Mymensingh at 12.75% (n = 3,750). Paddy fields were the preferred habitat (77.50%), followed by wetlands (10.94%), mixed agriculture (5.51%), tea gardens (3.74%), mango orchards (1.95%), and homesteads (0.36%). Breeding occurred from April to July, with colony sizes ranging from 2–2,260 nests. A total of 29,412 active nests were counted from 1,963 plants of 42 species, with a preference for Bamboo (76.32%), followed by Mango (7.77%), Jackfruit (3.14%), and Tamarind (2.51%). They usually laid 3–4 eggs in 4–8 days, with an incubation period of 25–29 days. Chicks fledged after 35–45 days, and breeding success was 63.50%.

Keywords: Ardeidae, active breeding colony, breeding success, habitat, heronry, nest, nesting site, spatial distribution, waterbirds, wetland.

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Author contributions: Allama Shibli Sadik: Conceptualization (lead); funding acquisition (lead); investigation (lead); project administration (lead); data curation (lead); formal analysis (lead); methodology (lead); visualization (lead); writing – original draft (lead); writing – review and editing (equal). M. Monirul H. Khan: Conceptualization (equal); investigation (equal); methodology (supporting); visualization (supporting); writing – original draft (supporting). M. Kamrul Hasan: Conceptualization (equal); investigation (equal); methodology (supporting); visualization (supporting); writing – original draft (supporting). Fahad Hossain Haider: Investigation (supporting); visualization (supporting); writing – review and editing (supporting). Md. Sher-E-Afgan: Investigation (supporting), including field surveys, trap-camera installation and monitoring, and documentation of breeding colonies; writing – review and editing (supporting).

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INTRODUCTION

Cattle Egret *Bubulcus ibis* is classified as a species of 'Least Concern' globally and nationally in the tropics, with a distribution that spans North & South America, Europe, Africa, Australia, and Asia and is widely distributed in Bangladesh (Begum 2008; Naher 2015; BirdLife International 2024). A majority of the population of this species is migratory, moving long distances for food, especially with seasonal rainfall, and some populations, like those in northeastern Asia and North America, are fully migratory (BirdLife International 2024). The population trend indicates an overall increase, though some populations are stable or declining, with others having unknown trends (BirdLife International 2024). The species thrives in various open grassy habitats, including meadows, pastures, floodplains, irrigated grasslands, as well as in small water bodies and artificial environments like lawns and parks that experience seasonal flooding (Hancock & Kushlan 1984; del Hoyo et al. 1992; Kushlan & Hancock 2005). This species rarely inhabits marine or forested areas (del Hoyo et al. 1992), although it can occasionally be found in brackish or saline environments (Kushlan & Hancock 2005; Byju et al. 2023). Its range spans from sea level to altitudes of up to 1,500 m (Kushlan & Hancock 2005), and in certain regions, it may even reach around 4,000 m (del Hoyo et al. 1992). In tropical regions, the species breeds year-round, with varying peaks in breeding activity depending on the availability of food resources and rainfall patterns, leading to annual fluctuations in productivity (del Hoyo et al. 1992; Kushlan & Hancock 2005; BirdLife International 2024; Byju et al. 2025a). This species breeds in colonies with group sizes from dozens to thousands of pairs (del Hoyo et al. 1992). These patterns illustrate the species' resilience and the importance of understanding environmental conditions that affect breeding success (Ballerini et al. 2009; Byju et al. 2024). During the non-breeding season, these birds remain social (Brown et al. 1982; del Hoyo et al. 1992; Birdlife International 2024). del Hoyo et al. (1992) observed feeding behaviour in loose flocks including 10–20 individuals; as well as the regularity with which bigger groups of hundreds or even thousands meet when food is plentiful.

The Cattle Egret *Bubulcus ibis* plays a significant ecological role in both agricultural and wetland ecosystems by controlling insect populations, particularly pests associated with livestock and crop fields (Kushlan & Hancock 2005). The species serves as an important bioindicator of wetland health and environmental change (Burger et al. 1992; Begum 2008) in Bangladesh, where agro-ecosystems and wetlands are vital for livelihoods. Hence, the conservation of Cattle Egret colonies reflects broader ecosystem integrity and supports biodiversity management within human-dominated landscapes. There is no comprehensive study yet conducted on the breeding ecology of Cattle Egrets in Bangladesh. The primary goal is to investigate their breeding ecology, including colony distribution, population abundance, nesting plant requirements, and conservation status. Although the Cattle Egret is widely distributed, it exhibits the distinctive behaviour of nesting in dense assemblages, resulting in breeding concentrated within a limited number of sites. Consequently, the loss of even a few breeding areas could have significant implications at the population level. Regional studies on its breeding ecology are therefore essential to evaluate local responses to habitat alteration, anthropogenic disturbance, and climatic variability. Such investigations provide critical baseline data and fill knowledge gaps for the long-term monitoring and conservation of the species within Bangladesh's rapidly changing wetland and agro-ecosystem landscapes.

MATERIAL AND METHODS

The study was conducted in the northern and northeastern regions of Bangladesh across 24 districts of Rajshahi, Rangpur, Mymensingh, and Sylhet (Image 1). Nesting site data collection was done from March 2017–August 2023. During the COVID-19 lockdown (2020–2021), the core survey team was unable to conduct direct field visits. Nevertheless, local field assistants, activists, community members, and other stakeholders played a crucial role in providing locational information on colony sites. Detailed investigations on population size, breeding ecology, and reproductive success were subsequently conducted in the post-pandemic period (2022–2023) to ensure consistency in environmental conditions and to minimize potential data bias arising from altered human activities during the lockdown. A total of 345 field days (approximately 13–15 days per district) were spent on population estimation and breeding ecology, covering at least two breeding seasons. Multi-stakeholder focus group discussions (FGDs) were held at the sub-district (upazila) and union levels following Krueger & Casey (2014). Direct field visits and use of citizen science (newspapers, eBird, social media), local conservation activists, youth conservation group members, and union parishad chairmen helped to locate

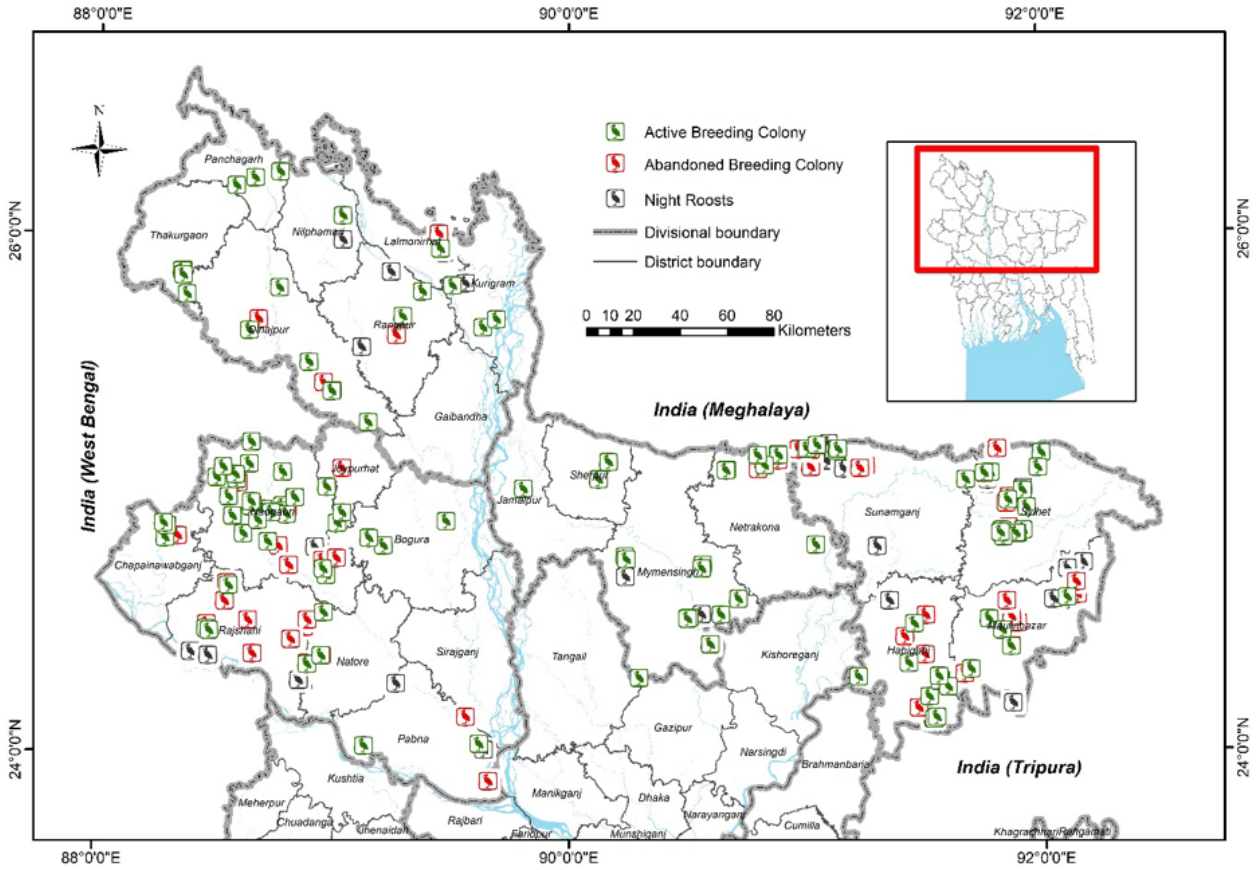

Image 1. GIS-based distribution map of the nesting sites and key habitats of Cattle Egret in all 24 districts of Rajshahi, Rangpur, Mymensingh, and Sylhet division.

the nesting sites. Identification of birds was done using field guides (Grimmett et al. 1999). Breeding pairs were considered independent colonies if they were at least 400 m apart from neighbouring groups or separated by a significant habitat discontinuity (Watts & Watts 2018). Field observations utilized binoculars (10 x 42), a spotting scope, GPS, measuring tape, laser rangefinder (Trupulse 200x), camera traps (GardePro & Scout Guard), a drone, and a digital camera. If there were young chicks or at least one adult in the nest, the nest is clearly categorized as active or occupied (Bibby et al. 2000). Population estimates were based on the count of active nests during the breeding season. The census was conducted at the peak nesting period to assess the number and distribution of nests (pairs). Observers systematically recorded the tree number, species, nest height, and total number of nests. Each tree with a nest was tagged with a unique number and marked with paint to indicate it had been counted. The six main habitat groups are paddy fields (rice farming), mixed agriculture (varied crops in dry lands), homesteads (urban settlements), orchards (areas with mango trees), tea gardens, and wetlands (ponds, rivers, marshes, and lakes). Land-cover data were derived from satellite imagery and reclassified to match the analytical requirements of the study. The reclassified land-cover layer was then clipped to a 5-km radius buffer surrounding each colony to assess the types of land cover associated with colony establishment. Each land-cover class within the buffer was assigned to the corresponding colony using a unique colony identifier. For every colony, the area (ha) and proportional (%) representation of each land-cover category were calculated. All spatial analyses were conducted using the Spatial Analyst tools in ArcGIS Pro 3.3, and tabular computations and summaries were performed in Microsoft Excel 365.

The age of the colony, defined as the duration of nesting site use by Cattle Egrets, was primarily determined from historical records (e.g., government reports, social media, and print and electronic media) and corroborated with community-based knowledge. Scientific literature, government reports, and historical accounts can provide information on the duration of colony site use (Ogden 1994). Interviews with local

communities and indigenous peoples can also offer valuable insights into the history of colony sites (Gawlik 2006). We marked 36 nests on five plant species: Jackfruit *Artocarpus heterophyllus*, Bamboo *Bambusa* spp., Mango *Mangifera indica*, Velvet Apple *Diospyros discolor*, and Sandpaper Tree *Streblus asper*. Eleven nests were monitored using camera traps at four colony sites: Chanpukur Mission and Alidewna in Naogaon, Teligaon in Tahirpur, and Lilapara in Khadimnagar, Sylhet. Each nest had a GardePro or Scout camera installed for about 55 days, capturing motion and photos every four minutes. Nesting success was recorded when at least one egg hatched per nest, while fledgling success was the proportion of chicks that fledged. Breeding success is calculated as the ratio of surviving chicks to the total number of eggs laid. Hatching success is the proportion of eggs that hatch successfully, while total breeding success measures the number of chicks that survive compared to the number of eggs laid (Katuwal et al. 2022). Data were analyzed using computer-based statistical models, including linear regression and GIS, to identify colony locations, habitat preferences, and distribution patterns of Cattle Egrets.

RESULTS AND DISCUSSION

Status and distribution of nesting colonies

A total of 218 colony sites were identified, of which 56.42% (n = 123) were active breeding colonies, 17.43% (n = 38) were night roosting, and 26.15% (n = 57) were breeding abandoned. The total area of active breeding colony sites was 107.06 ha, including 1.10 ha of government land and 105.96 ha of private land. The age of nesting sites ranged from 2 to 150 years (mean 20.78 ± 29.14 SD, n = 123), with one site in Domar, Nilphamari, estimated to be 200 years old. Nesting sites were reused annually (n = 123) as long as the habitat remained suitable and undisturbed. The highest number of active breeding colonies was found in the Rajshahi (n = 41) and Sylhet divisions (n = 41), followed by Rangpur (n = 21) and Mymensingh (n = 20). Naogaon District had the most nesting sites (n = 25) (Image 2), while Pabna, Lalmonirhat, and Jamalpur had the least (n = 1), with no nesting sites in Sirajganj and Gaibandha (Image 1). The highest percentage of nests was found in the Rajshahi division (38.29%, n = 11,262), followed by Sylhet (29.47%, n = 8,669), Rangpur (19.49%, n = 5,731), and Mymensingh (12.75%, n = 3,750) (Image 3). The number of active nests varied notably across the four divisions. Rajshahi recorded the highest number of colonies and nests, with an average of about 275 nests per colony, indicating highly productive nesting activity. Rangpur showed a similarly high average of 273 nests per colony, reflecting strong colony performance relative to its size. Sylhet had an average of 211 nests per colony, while Mymensingh showed the lowest productivity, with 188 nests per colony. Overall, Rajshahi and Rangpur exhibited higher nesting densities per colony, whereas Sylhet and Mymensingh showed comparatively lower nesting intensity, suggesting potential differences in habitat quality, resource availability, or colony maturity among the divisions.

The linear regression analysis revealed a positive relationship between the number of colonies and the number of nests, with each additional colony associated with approximately 257 more nests. The model explained a substantial proportion of the variation in nest numbers (R^2 = 0.85) (Image 5A). However, the relationship was not statistically significant at the 0.05 level (p = 0.077). Nevertheless, the trend indicates that an increase in the number of colonies generally corresponds to a higher number of nests. The study results indicate that habitat suitability for Cattle Egret colonies varies considerably across northern and northeastern Bangladesh. The highest number of active breeding colonies and nests was recorded in the Rajshahi and Sylhet divisions, suggesting these areas provide optimal conditions for nesting. Factors contributing to this suitability likely include the presence of abundant suitable trees for nesting, low human disturbance, and proximity to productive foraging habitats such as wetlands and agricultural fields. In contrast, Mymensingh had fewer colonies and nests, while districts such as Pabna, Lalmonirhat, and Jamalpur hosted limited nesting sites. Nesting was completely absent in Sirajganj and Gaibandha, clearly indicating that these areas likely lack suitable nesting trees, experience higher levels of human disturbance, or have limited access to nearby foraging grounds, thereby reducing their suitability for Cattle Egret colonies. Moreover, hunting pressure was higher in Mymensingh than in other regions, which could have limited the breeding of the Cattle Egret.

Breeding season, habitat and nesting site selection

Nest construction occurs from April to June, with breeding occurring between April and July. Breeding season varied in the study area: nest construction started early April in the Sylhet division, and the nest construction started in mid to late May in Rajshahi, Rangpur, and Mymensingh divisions. The core breeding time in the Sylhet division was April to early June, while

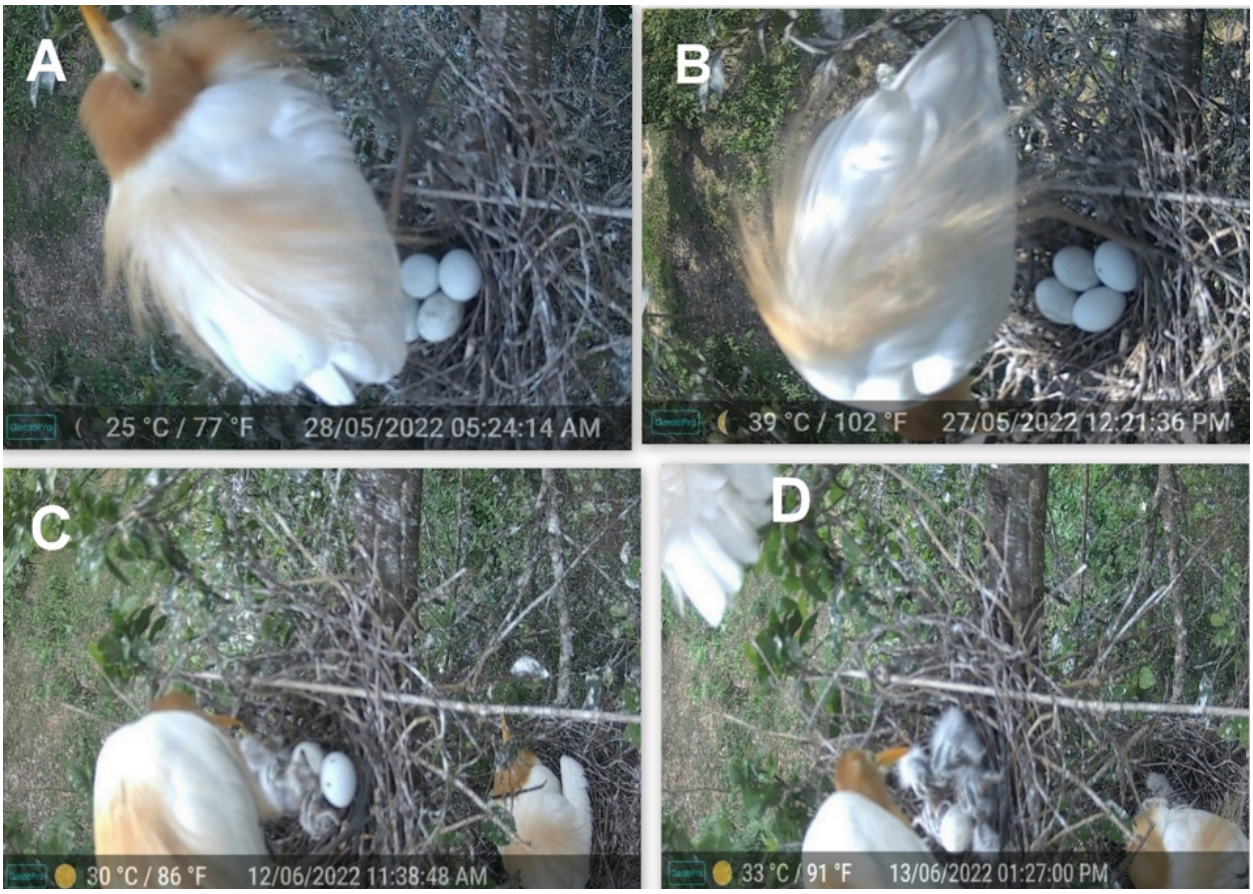

Image 2. Incubation of eggs (A & B) and hatchlings with unhatched eggs (C & D) at Chanpukur Catholic Church Bird Colony, Patnitala, Naogaon. © Allama Shibli Sadik.

in Rajshahi, Rangpur, and Mymensingh, it was mid-May to July. The most nesting sites and nests were found in paddy field habitats (89 sites, 22,795 nests), followed by wetlands (16 sites, 3,217 nests), agricultural mixed habitats (7 sites, 1,620 nests), tea gardens (seven sites, 1,099 nests), mango orchards (2 sites, 575 nests), and homesteads (1 site, 106 nests). A total of 123 colonies were identified, with six as single colonies and the others as mixed-species colonies alongside egrets, herons, cormorants, darters, storks, and ibises. All the nesting sites were associated with human settlements (Issa et al. 2023), including rural villages and urban areas, where feeding grounds were within easy reach. This observation strongly supports the findings of the present study. The number of active nests and nesting sites varied notably across habitats. Paddy fields supported the highest total number of nests with a high density of about 256 nests per site, indicating favourable nesting conditions. Mango orchards, though limited to two sites, showed the highest density (288 nests per site), suggesting strong site productivity. Homesteads had the fewest nests, while agriculture-mixed areas and wetlands provided moderate nesting opportunities, and tea gardens supported relatively fewer nests per site. The linear model revealed a strong positive relationship between the number of nesting sites and the number of nests. Each additional nesting site was associated with approximately 260 more nests on average. The model explained nearly all the variation in nest numbers (R^2 = 0.998) (Image 5B), and the relationship was highly significant ($p < 0.001$). These results indicate that the number of nesting sites serve as a strong predictor of nest abundance across habitats.

Colony sizes varied, ranging 2–2,260 nests (mean 116.25 ± 225.52 SD, n = 123). The largest colony, in Akandapara, Bogura, had 2,260 nests. Colony size depends on the number of nesting plants and the area's safety for establishing nests . Cattle Egrets are colonial nesters, often found with other species like herons and storks (Snow & Perrins 1998; Bharti 2024). Cattle Egrets nest in various tree types, with height preferences influenced by environment and human activity (Si-Bachir et al. 2008; Sbiki et al. 2015). A total of 29,412 active nests was observed among 1,963 plants of 42

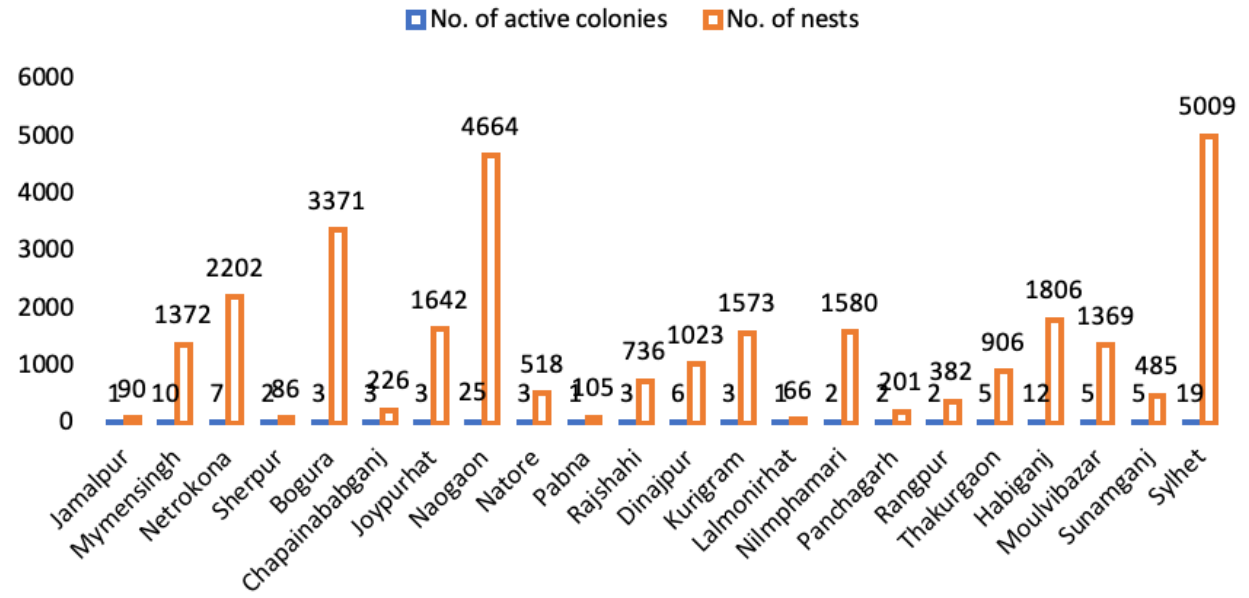

Image 3. Average nesting height of the tress/plants preferred by Cattle Egret.

species. They primarily favoured Bamboo *Bambusa* spp. (76.32%), followed by Mango *Mangifera indica* (7.77%), Jackfruit *Artocarpus heterophyllus* (3.14%), Tamarind *Tamarindus indica* (2.51%), and least often Scholar Tree *Alstonia scholaris* with one nest. Cattle Egrets often nest in trees at heights of 4–17 m; the mean average nesting height was 4.3–15 m (mean 10.30 ± 2.81 SD, n = 1963); the mean lowest height was 4.2–15 m (mean 9.22 ± 2.50 SD, n = 1963); and the mean highest height was 5.8–17 m (mean 11.06 ± 2.71 SD, n = 1963). The lowest height was 3 m nesting at the Bamboo *Bambusa* spp. cluster, and the highest nesting height was 17 m at African Mahogany (Image 4). In Gujarat, Patankar et al. (2007) reported that the average nesting height on *Mimusops* trees was 8.6 m, whereas on *Lagerstroemia* trees it averaged only 3.7 m. In Faisalabad, Pakistan, nests were primarily built in Kikar *Acacia nilotica* trees, followed by Jamun *Syzygium cuminii* trees, at average heights ranging 7.19 ± 1.45–8.01 ± 1.31 m above the ground (Abdullah et al. 2017). These findings are consistent with the results of the present study, indicating that Cattle Egrets preferentially select tall trees for nesting and subsequently use other available suitable trees within heronries. Wayne et al. (1998) reported relatively low nesting heights on Montserrat, West Indies, averaging 2.1–5.7 m above the tree canopy, suggesting potential variability in nesting preferences across different regions. Cattle Egret breeding seasons vary by region: in temperate areas, it happens from spring to late summer, while in tropical regions, it can occur year-round, often during the rainy season (Hancock & Kushlan 1984). The breeding period starts from March to July in Jammu, India (Novel & Sahi 2013), and the breeding season in Bangladesh is from June to August (Begum 2008), but our study found that they regularly breed from April to July. The breeding season varies by region: in Sylhet, it runs from early April to late June, while in Rajshahi and Rangpur, it lasts from mid-May to late July due to food availability, as they nest in paddy fields and agricultural dominated habitats. Flash floods upstream of Meghalaya have caused waterlogging in the Sylhet division, benefiting early-harvesting rice crops. In contrast, delayed rains in Rajshahi and Rangpur divisions have left rice fields dry, resulting in insufficient food supply in April. The rainy season in Rajshahi and Rangpur divisions starts in mid-to-late May, nourishing the auricular rice fields and providing ample food, determining the breeding season. Local regional rainfall positively correlated with nest numbers (Novel & Sahi 2013). Cattle Egrets are adaptable and thrive in various environments, but their breeding season timing varies by location and climate. Insufficient rainfall can interrupt breeding (Geering 1993; Kushlan & Hancock 2005; Ballerini et al. 2009; Kelly & Condeso 2014).

Cattle Egret colony sizes vary considerably across regions. Reports include 107 nests in France and Morocco (Hafner 1978; Franchimont 1985); 1,222 in Brazil (Petry & Fonseca 2005); 550–7,953 in India (Hilaluddin et al. 2003; Novel & Sahi 2013); 1,416 in South Africa (Siegfried 1972); and 4,500 in the USA (Dusi & Dusi 1970). More localized studies further highlight

Table 1. Nesting tree/plant species preferences.

Plant species	No. of plants	No. of nests
African Mahagoni *Khaya anthotheca*	12	63
Agar *Aquilaria malaccensis*	53	90
Acacia *Acacia auriculiformis*	41	143
Hog Plum *Spondias pinnaata*	1	7
Arjan *Terminalia arjuna*	18	103
Babul Tree *Vachellia nilotica*	2	51
Stone Apple *Aegle marmelos*	1	3
Spanish Cherry *Mimusops elengi*	3	22
Bamboos *Bambusa* spp.	912	22450
Indian Plum *Ziziphus mauritiana*	4	101
Banyan Tree *Ficus benghalensis*	2	32
Scholar Tree *Alstonia scholaris*	1	1
Coconut *Cocos nucifera*	15	15
False Ashoka *Monoon longifolium*	14	96
Eucalyptus *Corymbia citriodora*	2	13
Velvet Apple *Diospyros discolor*	3	34
Indian Oak *Barringtonia acutangula*	3	15
Jackfruit *Artocarpus heterophyllus*	105	925
Black Plum *Syzygium cumini*	19	113
Betel-nut Palm *Areca catechu*	108	128
Tala Palm *Borassus flabellifer*	7	20
Tamarind *Tamarindus indica*	47	740
Queen Flower *Lagerstroemia speciosa*	19	132
Kadam *Neolamarckia cadamba*	10	50
Carambola *Averrhoa carambola*	3	21
Indian Date Palm *Phoenix sylvestris*	10	27
Wood Apple *Limonia acidissima*	2	15
Koroch *Dalbergia reniformis*	8	92
White Siris *Albizia procera*	6	86
Lichi *Litchi chinensis*	2	21
Mahagoni *Swietenia mahagoni*	92	440
Mango *Mangifera indica*	299	2286
Neem *Azadirachta indica*	68	269
Sacred Fig *Ficus religiosa*	9	153
Fishtail Palm *Caryota urens*	3	16
Royal Siris *Albizia richardiana*	1	16
Indian Laurel *Litsea glutinosa*	1	6
False White Teak *Trewia nudiflora*	20	145
Pithraj *Aphanamixis polystachya*	1	21
Rain Tree *Albizia saman*	13	235
Indian Rosewood/Shisham *Dalbergia sisu*	9	72
Sandpaper Tree *Streblus asper*	14	144

this variation: 550 nests were documented in a mixed colony in Amroha, Uttar Pradesh, India (Hilaluddin et al. 2003); Issa et al. (2023) reported 135 nests in Sharkia Governorate, Egypt; and Patankar et al. (2007) counted 159 nests in an industrial area of Vadodara, Gujarat. Nesting substrates also vary widely, including trees, bamboo, palms, and occasionally the ground or reed beds, depending on local availability (Hancock & Kushlan 1984). In contrast, our study found that Cattle Egrets in Bangladesh bred exclusively in trees and shrubs, such as bamboo clusters and palms, with no nests observed on the ground or in reed beds. Similar regional variability in nesting plant selection has been reported in Jammu, India, where *Acacia nilotica* is the preferred nesting tree, followed by *Mangifera indica* (Novel & Sahi 2013), *Neltuma juliflora* and *Acacia nilotica* in Tamil Nadu (Byju et al. 2025b), underscoring the influence of local habitat conditions and anthropogenic pressure on nesting ecology.

Courtship, nest building, egg-laying, and incubation

During courtship displays, various behaviours such as mutual grooming, bill-touching, and an array of postures, body colours, and vocalizations were observed. The birds built simple, oval nests atop trees or tall shrubs using sticks and various plant materials. After pairing, they copulated. Cattle Egrets typically lay 3–4 eggs (mean 3.80 ± 0.40 SD, n = 36), and clutch size was completed in 4–8 days. They built new nests each year, but do not reuse them the following year. Incubation begins with the first egg laid, with both parents sharing the duty for around 25–29 days (mean 26.5 ± 1.5 SD, n = 6). This allows one to guard the nest while the other forages. Nesting success was 100%, with hatching success 81.02%.

The nests were constructed from twigs, sticks, and other plant materials, with males primarily responsible for collecting the materials and females arranging them into a stable structure. Nesting materials were mostly gathered from nearby areas, and in some cases, individuals were observed stealing materials from neighbouring nests within the same colony; such type of behaviour was reported by Iyer (2004) and Patankar et al. (2007). Although previous studies noted that Cattle Egrets often reuse their nests across multiple breeding seasons when conditions remain favourable (Kushlan & Hancock 2005), the observations differed, as the birds in the present study built new nests each year.

Females typically lay 2–5 eggs per clutch (Kushlan & Hancock 2005; Begum 2008; Issaa et al. 2023). Patankar et al. (2007) reported a relatively smaller clutch size of 2–3 eggs in Gujarat, suggesting that clutch

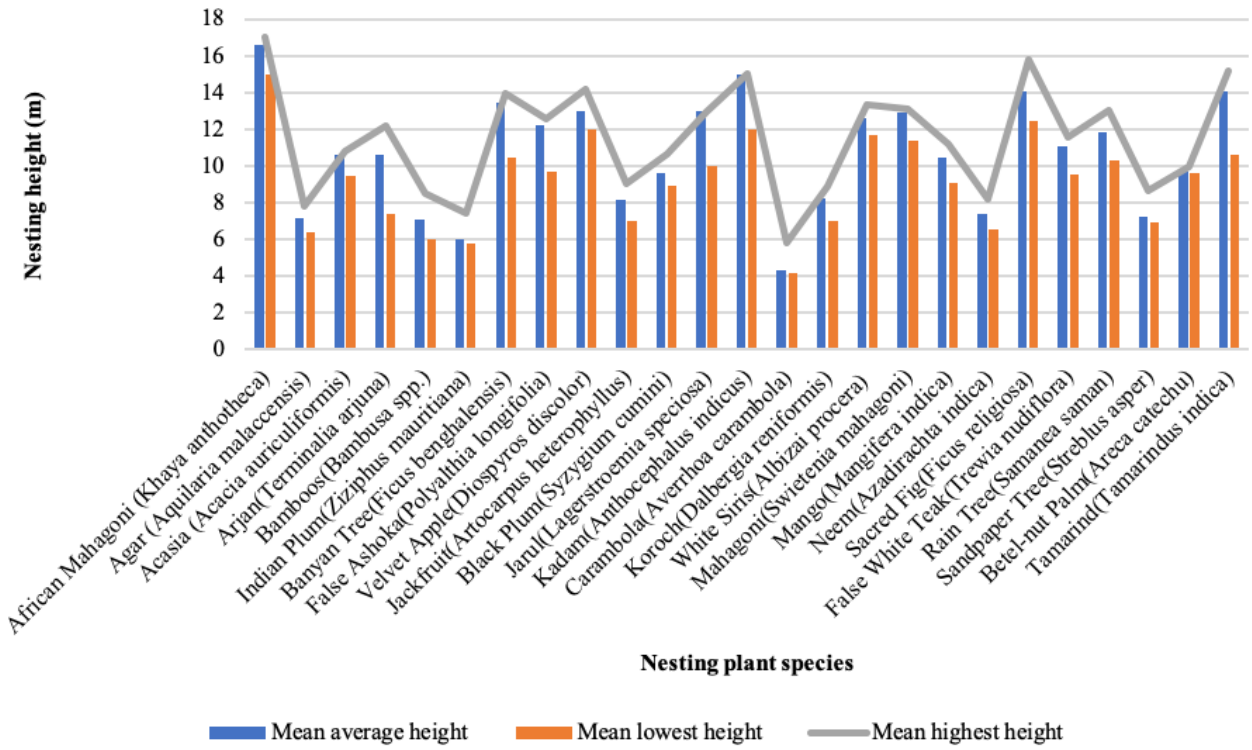

Image 4.. Average nesting height of the tress/plants preferred by Cattle Egret.

size may vary geographically, possibly influenced by environmental conditions and resource availability. Both parents share incubation duties. Reported incubation periods for *Bubulcus ibis* vary widely, ranging 19–27 days: about 3–4 weeks (Kushlan & Hancock 2005); 21–23 days (Novel & Sahi 2013); 21–24 days (Joshi & Shrivastava 2012); 22–23 days (Patankar et al. 2007); 22–25 days (Abdullah 2017; Issaa et al. 2023); 19–22 days (Omar & Hassan 2019). Begum (2008) reported 24 days, while Fujioka (1984) recorded 22–27 days in central Japan—both closely matching our observations. Overall, incubation duration in *B. ibis* shows notable regional variation, likely influenced by environmental conditions and food availability. Overall, variation in incubation duration appears to reflect the combined effects of environmental conditions, food availability, and parental behavioural traits (Higgott et al. 2020). Telfair & Bister (2004) reported that hatching success of Cattle Egrets in northeastern Texas ranged from 71% to 96%. Similarly, Issaa et al. (2023) recorded success rates of approximately 90.21%, while Metallaoui et al. (2020) observed 80%, 90%, and 100% hatching success in different colonies across Algeria. These earlier studies broadly support the findings of the present research. In contrast, relatively lower nesting success has been reported by Kour & Sahi (2013) in Jammu, India, indicating that regional environmental factors and habitat conditions can influence reproductive outcomes.

Parental care

After hatching, the altricial chicks were undeveloped and relied on their parents for food and warmth. The chicks needed warmth for 10–13 days after hatching. They remained in the nests until 18–22 days and started venturing out over the next 5–7 days. By around 30–35 days, they were rarely seen at the nest, but would return for parental feeding. Both parents feed the chicks by regurgitating partially digested food into their mouths. Fledgling survival was 78.37%. Cattle Egrets provide a well-documented example of intensive parental care, with both male and female actively involved in rearing and weaning their chicks (Patankar et al. 2007; Abdullah et al. 2017). Altricial chicks require close parental care and provisioning in the early weeks. Soon after hatching, adults feed them with regurgitated food, teaching chicks to take it from the partially opened beak (Abdullah et al. 2017).

Observations revealed that the diet of *Bubulcus ibis* included a diverse range of prey such as insects, small fish, and amphibians, including frogs and tadpoles, reflecting the species' opportunistic, generalist feeding strategy (Kushlan & Hancock 2005). The weaning period

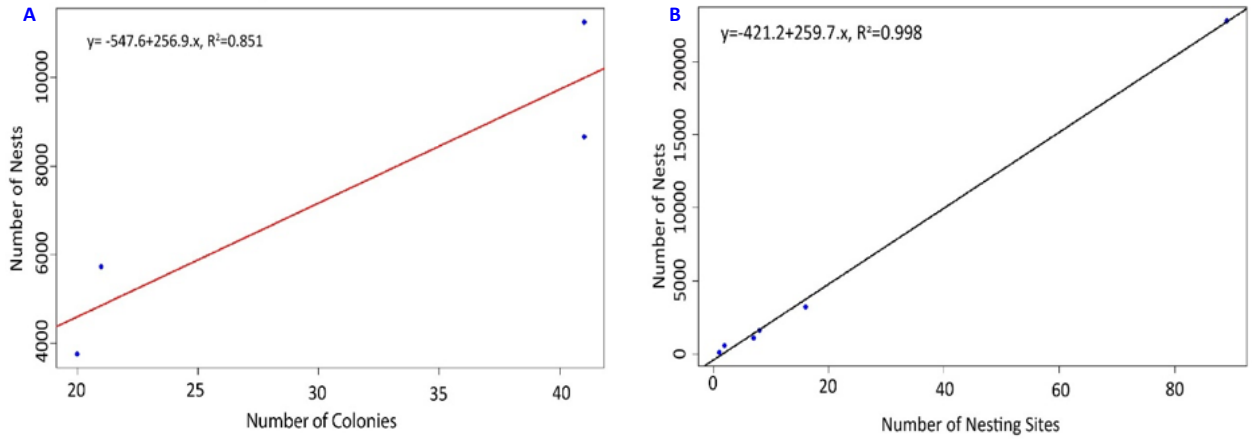

Image 5. A—Relationship between the number of colonies and the number of nests across divisions | B—habitats.

ranged from 25–35 days, supporting Abdullah et al. (2017), while slightly shorter durations of 21–28 days and 21–23 days were reported by Patankar et al. (2007) and Kour & Sahi (2013), respectively. These findings highlight the species' consistent parental investment and suggest that variation in weaning period may be influenced by environmental conditions, food availability, and colony dynamics. Overall, biparental care and structured feeding behaviours appear crucial for chick survival and successful fledging in Cattle Egrets.

Predator defense and post-breeding dispersal

Cattle Egret nesting colonies benefited from protection by cattle and humans but remained vulnerable to predators like crows, snakes, and raptors. Cattle Egrets exhibited collective defense behaviours like mobbing intruders and distracting predators. After breeding, they dispersed to various habitats, such as wetlands, rice fields, and grasslands, based on food availability. The final breeding success was 63.50%. Chicks fledged (left the nest) after about 35–45 days. Both parents actively cared for and fed the nestlings with dedication. At 45 days, they are self-sufficient; by 50 days, they take short flights; and at about 60 days, they fly to foraging sites (Telfair 1994). In Jammu, India, hatching success is 58.65%, whereas chick survival or breeding success is 39.99% (Novel & Sahi 2013). In Australia, annual breeding success is between 1.8 and 2.9 fledglings per pair (McKilligan 2000). About 28-year research in Texas revealed a mean annual breeding success of 86% (Telfair & Bister 2004). According to our findings, chicks fledged after about 35–45 days; the hatching success rate was 81.02%, the fledging survival was 78.37%, and fledgling success per pair/nest was 41.37%, or 2.41 per nest. Bangladesh had higher hatching and chick survival rates than Jammu. The breeding success is roughly comparable to that of Texas, and it is also extremely close to Australia. Cattle Egret nesting colonies benefited from protection by cattle and humans but remained vulnerable to predators like crows, snakes, and raptors. Cattle Egrets exhibited collective defense behaviours like mobbing intruders and distracting predators. Both parents actively cared for and fed the nestlings with dedication. After breeding, they dispersed to various habitats, such as wetlands, rice fields, and grasslands, based on food availability. In this study, hatching success was 81.02%, fledgling production averaged 2.41 per nest (41.37%), and overall breeding success was 63.50%. Chicks fledged after 35–45 days, becoming self-sufficient by about 45 days, taking short flights by 50 days, and flying to foraging sites by 60 days, consistent with Telfair (1994). In Australia, annual breeding success is between 1.8–2.9 fledglings per pair (McKilligan 2000), and in Texas, breeding success 86% (Telfair & Bister 2004), which supports our study. But a previous study in Jammu, India show the relatively low hatching success 58.65% and also the breeding success 39.99% (Novel & Sahi 2013). Overall, breeding performance in Bangladesh was higher than in Jammu and generally aligned with findings from Australia and Texas.

CONCLUSION

The Cattle Egret has received little attention in Bangladesh, so the species has faced significant threats in the study area, resulting in the abandonment of 57 nesting sites over the past five (2019–2023) years. This is primarily due to habitat loss caused by cutting

down the nesting trees, chick poaching, hunting, and poisoning of adult birds. Specifically, 66% of colonies were abandoned because of habitat loss, while 44% were lost to various human activities. Effective conservation should ensure the protection of the crucial breeding sites and raise awareness among the local communities about the importance of birds. This study suggests several conservation measures, including habitat protection, compensation for resource damages, installing signboards at colony sites, enforcing laws against bird hunting and poaching, hiring wildlife watchers, and constructing sheds beneath nesting trees during breeding seasons. The study findings can aid in developing targeted conservation plans.

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